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NUMERAL SYSTEM

802 The notes on and analysis of Cayapa numerals here given were made the subject of a short contribution to the *Putnam Anniversary Volume*, 1909, in which they appear under the title of "The Cayapa Numeral System." They are based on the accompanying table of numbers, which runs to 10,000. Only one informant could carry the count above a few thousands, but there seems no doubt that the higher thousands here given are correct.

The Cayapa numeral system is a quinary-decimal-centenary one with certain variations, to be noted later, and the rules on which it is based are well fixed and regular. In it there are certain points of special interest. One of these is its centenary nature, according to which there is no separate term for thousand; but hundred is used as the base of all numbers from 100 up, thus making a number like 4000 forty hundreds, not four thousands.

Also, there appear two terms which show what may be regarded as traces of other systems, though on account of the lack of other terms in support of these systems, they must be treated as only possibilities. Four is formed on the base two, thus showing what may be a trace of a binary system; but this is the only evidence of such a system found in the whole series of numbers. Especially significant in considering this term is the fact that three exists independently of two, and thus points strongly to a system higher than the binary. The second extraneous term is twenty, which appears entirely unrelated to any of the other numbers, either lower or higher. This might be taken as a trace of a system of

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vigesimal nature, but it lacks even so much support as four, and the binary system for it has not even one other number of a form in any way resembling it. On the other hand, though two other terms of the system are held in common with a neighboring language, the terms for four and twenty do not show this indication of possible borrowing either by one people or the other.

An unusual feature here shown is the use of two distinct terms for the same number in two different parts of the system. This occurs in ten, where *pa'it'a* is used up to nineteen; and *tcũ'ũga*, apparently a borrowed term, from thirty up.

The order given to the figures of the various denominations is as follows:

All compound numbers from ten up which contain a figure of the units order have this as the final term. Thus thirteen is ten three. The numbers six to nine are compounds of five with the four lower numbers. Here the same rule is followed and the numbers one to four are terminal.

In all tens and in all hundreds, which in this system include the thousands also, the term tens or hundreds is the final one, being preceded by the number of tens or hundreds in the numeral in question. Thus 40 is four tens, 400 is four hundreds, and 4000 is forty hundreds.

In no case is there found anything in the nature of a connective term between the parts of a compound number.

Following the phonetic laws of the language, certain terms, if not used as the ultimate ones, are changed when they occur in a compound numeral. Thus *pɛ'ma*

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•802 194 is the unit three, and *pa'it·a pēma* is thirteen, but *pē'ñ tcūñga* is thirty. So far as two and three are concerned, the change is regular and universal. One changes in the hundreds place in the numerals one hundred to one hundred ninety-nine, and in six when this occurs as a terminal figure. Five has three forms. According to these phonetic laws also, these numbers, when occurring in units or in the units place, undergo the same changes if followed by other terms possessing the necessary sounds. Thus, in the sentence "he has three new ollas," *ya-tcī kasa pē'n pīa'ma hūⁿ*, literally "his new three ollas has," the change of form of the numeral is necessary. Equally correct, however, is *ya-tcī kasa pıa'ma pēma hūⁿ*, in which the surrounding sounds do not necessitate the change. It appears also that the numbers two and three, and perhaps one and five, may exert an influence upon the term following, as in the cases of *pa'i patsa* and *pē'ñ batsa*, in which the change of the second term would seem to be related to the preceding sounds.

Rules of Composition

802 The numbers on which the Cayapa numeral system is based are 1, 2, 3, 5, 10, 20, and 100. On these the composition proceeds as follows:

Four is *ta*-2.

Six to nine are 5-*dic* 1, 2, 3, and 4 respectively.

Ten alone and as a component of the numbers 11 to 19 and other higher numbers in which these occur is *pa'it·a*, a term quite different from tens (*tcū'ñga*) used

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in the composition of the tens from 30 up and in all higher numbers in which these occur. 802

Beginning with 11 all units proceed regularly by the simple addition of the unit terms 1 to 9 to the particular ten under consideration.

Twenty has a name which, unlike the other tens, is not related in any way to the units.

Beginning with 30 all the tens proceed regularly by the addition of *tcū'ñga* to the unit terms 3 to 9, with certain changes in some of these terms, as elsewhere noted.

Hundred is the last grand division, and all the higher numbers are simply the term hundred preceded by the term indicating the number of hundreds in the particular numeral.

Basal Numbers

One occurs as a basal number in the following: In 1 where it is rendered *ma'iñ*; in 6, where it is rendered *ma'lyō*; and in 100, where it is rendered *mam*, and in all higher numbers containing one of these in composition. In the accompanying table of numerals these three forms occur in the following numbers:

ma'iñ occurs in 1, 11, 21, 60, 101, 600, 1100, 1600, 2100, and 6000*
ma'lyō occurs in 6 and 16
mam occurs in 100, 101, 110, 120, and 10000.

Two occurs as a basal number in the following: in 2, 4, 7, and 9, in all of which it is rendered *pa'lyō*. It is

* While 1 in the composite number 6 is rendered *ma'lyō*, this is true only where 6 is the terminal figure in the higher composite numbers. In all other cases it is rendered *ma'iñ*.

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802 also rendered *pa'lyō*, if in the units place, in all higher numbers in which any of these four occur. If, however, they appear in the tens or a higher column, 2 becomes *pai*, as is the case in ordinary sentence structure; for instance, *pai kū'tca*, two dogs. An exception appears in 20 and 2000, since 20 is rendered by a term, *ma'n-tcalōra*, entirely unrelated to any of the other numbers and also since the system proceeds strictly on a centenary basis from 100 up.

In the accompanying table these two forms occur as follows:

pa'lyō occurs in 2, 4, 7, 9, 12, 14, 17, and 19.
pai occurs in 40, 70, 90, 200, 400, 700, 900, 1200, 1400, 1700, 1900, 2200, 4000, 7000, and 9000.

Three occurs as a basal number in 3 and 8, in both of which it is rendered *pē'ma*, and in all higher numbers which contain either of these. In all cases in which either occurs in the units column it retains its original unit form given above. Wherever it occurs in the tens or in a higher column its form is changed to *pēñ*, here again following the ordinary phonetic rules. These two forms are here found in the following numbers:

pē'ma in 3, 8, 13, and 18.
pēñ in 30, 80, 300, 800, 1300, 1800, 3000, and 8000.

Five is used as a basal number as follows: in 5, where it is rendered *ma'n-da*, and 6, 7, 8, and 9, in all of which it is rendered *ma'n-dic*, and in all higher numbers in which these occur. In the higher numbers where 5 appears in any of the columns from the tens up, its

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form is *mañ*. Though 5 appears in the units as *ma'n-da*, it would seem, when its other forms are considered, that this is really a compound and that its simplest form is *man* or *mañ*. As with the lower numbers, in all cases in which 5 appears in the units column, it retains its unit form, but in all other cases it is changed. Since the system is in part of quinary one, 6 begins the second set or group, and 6, 7, 8, and 9 are composed of 5, with 1, 2, 3, and 4, respectively, added. In these the term 5 takes the form *ma'n-dic*, probably *ma'n-da-ic* in full. In this form it occurs in all the higher numbers in which 6, 7, 8, and 9 appear. As above stated, in any of the higher numbers in which 5 itself appears in any of the columns above the units, it has the form *mañ*, which is the same rendition that it has in a sentence when followed by such a term as *ya* or *kū'tca*, as *ma'ñ ya*, five houses, or *ma'ñ kūtca*, five dogs. In the list of numerals the three forms occur as follows:

ma'n-da occurs in 5 and 15.
ma'n-dic occurs in 6, 7, 8, 9, 16, 17, 18, 19, 60, 70, 80, 90, 600, 700, 800, 900, 1600, 1700, 1800, 1900, 6000, 7000, 8000, and 9000.
mañ occurs in 50, 500, 1500, and 5000.

Ten occurs as a basal number as follows: in the numbers 10 to 19, inclusive, where it is rendered *pa'il'a*, and in the higher numbers in which any one of these appears. This term ten is quite a different one from tens, *tcū'ñga*, which is used in the numbers from 30 up. This unusual use of a term for tens which is entirely distinct from the simple 10 appears to be explainable through borrowing, since in a neighboring

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802 [177] language, the Quichua,* both 10 and tens are rendered *tcū'ñga*, though the cause of such borrowing if such it is, remains uncertain. These two terms appear in the accompanying list as follows:

pa'it a appears in 10 to 19 inclusive, and in 1000 to 1900 inclusive.

tcū'ñga appears in 30 to 90 inclusive, and in 3000 to 9000 inclusive.

Twenty, *ma'ntcalōra*, one of the two exceptions to the regularity of this numeral system, appears as a basal number in 20 and in all higher numbers in which it, as such, occurs. In the accompanying list

ma'ntcalōra appears in 20, 21, 120, 2000, 2100, and 2200.

Hundred, *pa'tsa* or *ba'tsa*, depending on its phonetic surroundings, forms the base of all numbers from 100 up. This includes the thousands also, since the system is centenary above 100. Thus, 8000 is not eight thousands but eighty hundreds.

[193] * There is in Cayapa no nominal plural, hence *tcūñga* and *ba'tsa* are both singular and plural so far as form is concerned. The former, not being the term used for 10, is really used only in a plural sense, but the latter is used as both singular and plural. Further, the term *tcū'ñga* is, according to a short Quichua vocabulary obtained from a couple of informants temporarily on the Rio Cayapas, the regular term ten in that language and is used throughout their entire system. The term hundred has also a close parallel, *pa'tsak*, in Quichua, but, while Cayapa has a strict centenary system above 100, Quichua carries the hundreds only as far as 1000, which is *wara'ñga*, a term entirely unrelated to hundred.

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pa'tsa or *ba'tsa* appears here in 100, 101, 110, 120, 200 to 2200 inclusive and 3000 to 10000 inclusive. 802

	Cayapa Numerals	Analysis
1	*maiñ*	1*
2	*pa'lyō*	2
3	*pē'ma*	3
4	*ta'l-palyō*	*tal*-2
5	*ma'n-da*	5-*da*
6	*man-dic ma'lyō*	5-*dic* 1
7	*man-dic pa'lyō*	5-*dic* 2
8	*man-dic pē'ma*	5-*dic* 3
9	*man-dic ta'l-palyō*	5-*dic* *tal*-2
10	*pa'iṭ'a*	10
11	*pa'iṭ'a ma'iñ*	10 1
12	*pa'iṭ'a pa'lyō*	10 2
13	*pa'iṭ'a pē'ma*	10 3
14	*pa'iṭ'a ta'l-palyō*	10 *tal*-2
15	*pa'iṭ'a ma'n-da*	10 5-*da*
16	*pa'iṭ'a ma'n-dic malyō*	10 5-*dic* 1
17	*pa'iṭ'a ma'n-dic palyō*	10 5-*dic* 2
18	*pa'iṭ'a ma'n-dic pēma*	10 5-*dic* 3
19	*pa'iṭ'a man-dic ta'l-palyō*	10 5-*dic* *tal*-2
20	*ma'ntcalōra*	20
21	*ma'ntcalōra ma'iñ*	20 1
30	*pē'ñ tcū'ñga*	3 tens [See pp. 453-54]
40	*ta'l-pai tcūñga*	*tal*-2 tens
50	*ma'ñ tcūñga*	5 tens
60	*man-dic ma'iñ tcūñga*	5-*dic* 1 ten
70	*man-dic pa'i tcūñga*	5-*dic* 2 tens
80	*man-dic pē'ñ tcūñga*	5-*dic* 3 tens
90	*man-dic ta'l-pai tcūñga*	5-*dic* *tal*-2 tens
100	*mam ba'tsa*	1 hundred
101	*mam batsa ma'iñ*	1 hundred 1
110	*mam batsa pa'iṭ'a*	1 hundred 10
120	*mam batsa ma'ntcalōra*	1 hundred 20

* So far all efforts to reduce these terms to tangible objects such as are often used by primitive peoples in counting have not met with success.

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CAYAPA NUMERALS		ANALYSIS
200	*pai pa'tsa*	2 hundreds
300	*pēñ ba'tsa*	3 hundreds
400	*tal-pai pa'tsa*	*tal*-2 hundreds
500	*mañba'tsa*	5 hundreds
600	*man-dic ma'iñ batsa*	5-*dic* 1 hundreds
700	*man-dic pa'i patsa*	5-*dic* 2 hundreds
800	*man-dic pē'ñ batsa*	5-*dic* 3 hundreds
900	*man-dic ta'l-pai patsa*	5-*dic* tal-2 hundreds
1000	*pa'iṭ'a patsa*	10 hundreds
1100	*pa'iṭ'a ma'iñ batsa*	10 1 hundreds
1200	*pa'iṭ'a pa'i patsa*	10 2 hundreds
1300	*pa'iṭ'a pē'ñ batsa*	10 3 hundreds
1400	*pa'iṭ'a ta'l-pai patsa*	10 *tal*-2 hundreds
1500	*pa'iṭ'a ma'ñ batsa*	10 5 hundreds
1600	*pa'iṭ'a man-dic ma'iñ batsa*	10 5-*dic* 1 hundreds
1700	*pa'iṭ'a man-dic pa'i patsa*	10 5-*dic* 2 hundreds
1800	*pa'iṭ'a man-dic pē'ñ batsa*	10 5-*dic* 3 hundreds
1900	*pa'iṭ'a man-dic ta'l-pai patsa*	10 5-*dic* *tal*-2 hundreds
2000	*ma'ntcalōra patsa*	20 hundreds
2100	*mantcalōra ma'iñ batsa*	20 1 hundreds
2200	*mantcalōra pa'i patsa*	20 2 hundreds
3000	*pē'ñ tcūñga patsa*	3 tens hundreds
4000	*ta'l-pai tcūñga patsa*	*tal*-2 tens hundreds
5000	*ma'ñ tcūñga patsa*	5 tens hundreds
6000	*man-dic ma'iñ tcuñga patsa*	5-*dic* 1 tens hundreds
7000	*man-dic pa'i tcūñga patsa*	5-*dic* 2 tens hundreds
8000	*man-dic pē'ñ tcūñga patsa*	5-*dic* 3 tens hundreds
9000	*man-dic ta'l-pai tcūñga patsa*	5-*dic* *tal*-2 tens hundreds
10000	*ma'm batsa patsa*	1 hundred hundreds

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A SYSTEM OF MNEMONIC WRITING

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As has already been noted, the Cayapa have no written language and express nothing in writing of any kind. An interesting example of the power of adaptation, however, was given by one individual along this line. The incident, while it has no direct bearing on the general life and culture of the tribe as a whole, may perhaps be significant and of interest when the general subject of mnemonics and hieroglyphic writing is considered, for it shows how readily a single individual of a tribe may borrow a principle which is entirely foreign to the culture of his own people and, with this as a basis, may invent a new system which might give rise to an entirely new order of things if it were carried to its full possibilities. Furthermore, this system is of considerable interest from a phonetic point of view, since it shows that it is founded on strictly phonetic considerations and thus shows what may be termed the natural tendency of the mind of man to correlate and arrange at least some linguistic ideas along logical, phonetic lines.

On the arrival of the author in the Cayapa country he took up his residence with a prominent official of the tribe known, according to the present-day Spanish terminology, as "El Secretario del Gobernacion." When the author expressed a desire to learn the Cayapa language, his host manifested an equal desire to learn English. It was therefore mutually agreed that each should instruct the other. A beginning was made with the numeral system, the author being given the names of the Cayapa numerals. As the terms were pronounced,

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careful record of them was made in writing. However, when the Secretario was told the English numerals, he was entirely dependent on his memory, since no system of writing was known to him. On the following day, when each endeavored to recite his lesson to the other, the Secretario was greatly surprised to hear the author read from his notes and correctly pronounce the Cayapa numerals told him the day before, whereas he, on the other hand, had much difficulty in getting his pronunciation correct and in remembering certain of the English numerals. He asked the author how it was possible to remember these numbers and the pronunciation of them; and upon being told about the aid to the memory given by the writing, he was immediately desirous of trying such a plan himself. Being provided with pencil and paper, he thereupon carefully recorded the first ten of the accompanying set of mnemonic characters (fig. 29). With this paper before him he was able, on the following day, to the author's surprise, to recount with almost perfect exactness these first ten English numerals. A day or two more added another set, and in the course of about a week he had worked out a complete system of mnemonic characters for the numerals from one to one hundred. Furthermore, an interesting feature of this set of mnemonic characters is the fact that they are strictly decimal in their composition, whereas the Cayapa numerals form a much more complex system, it being quinary-decimal-centenary.

The units themselves appear to be entirely unrelated one to another, and as the author watched the Indian making these characters it was evident that a pure proc-

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ess of invention was evolving in his mind, his chief desire being in each instance to get some character that

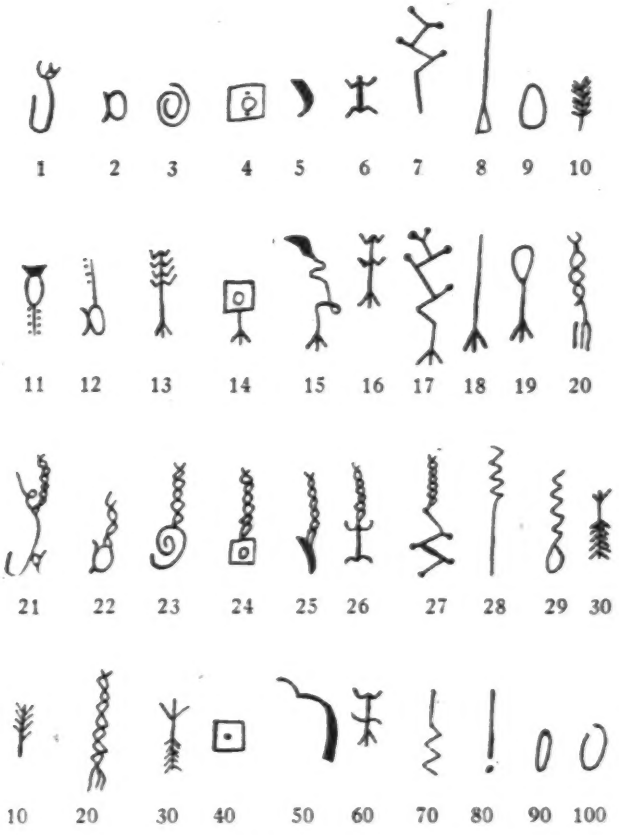

FIG. 29.—Mnemonic characters

should represent the particular number and which should be different from all the others.

In forming most of the characters to represent the

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numbers from eleven to nineteen he took carefully into account those representing the units one to nine. In fact, he always referred to these and in most cases reproduced them entirely, or in part, as portions of the characters representing the 'teens. Indeed the characters representing fourteen to nineteen are clearly and obviously these same unit characters with the addition of the crowfoot beneath, which represented to his mind the idea of 'teen—not that it was related to ten, but the crowfoot actually represented to him the sounds comprising 'teen. It is even more evident in thirteen, where the crowfoot first appears but where the unit character for three is not present, that the various parts of these characters actually represented to his mind sounds, rather than precisely correlated ideas of the numeral system. This became clear whenever he used this table of characters, for when he first repeated these numbers he did so very slowly and pointed to the particular part of the character which represented the sound which he was speaking. For instance, in the case of fourteen he would point to the square enclosing the circle and say "four;" then his pencil would go down to the crowfoot and he would say "teen." Likewise in nineteen the oval was nine and the crowfoot 'teen. As still further evidence of the phonetic nature of these mnemonic characters, eleven and twelve are excellent examples. To our minds eleven and twelve belong logically to the set of 'teens, though "'teen" does not appear in them. To the Cayapa's mind, however, the vertical line with the four dots on each side in the sign for eleven represented "e," and the oval with its heavy crescent above

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represented "leven." Likewise, in the case of twelve, the oval with the crescent on the side represented "two," and the vertical line with the four dots on the left represented "helve." Furthermore, he learned this number not as twelve but as "two-helve," and no amount of correction at any later time could change his pronunciation. In both of these instances we have a composition of the character along strictly phonetic lines. In the higher numbers a similar condition prevailed, though in many instances the same sound or set of sounds was represented by different characters. For instance, the "ty" in the higher tens was variously represented. In fifty it was the long heavy curved line, in sixty the crowfoot, and eighty the dot. In each instance this character forms the lower part of these respective characters. In seventy it was the vertical line, and in thirty the crowfoot, which form in these instances the upper part of the character. Forty and ninety are simply four and nine somewhat altered.

As above mentioned, the idea of the addition of ten to the unit in the numbers eleven to nineteen is indicated by joining directly to the characters one to nine certain other characters representing the sounds, not the idea, expressed in "teen." Likewise also in the numbers twenty-one to twenty-nine. The upper part of the character twenty is joined directly to the unit character and forms an integral part of it. From thirty onward, however, a different method was used. Here the unit character was placed directly after the character representing the particular ten which was being used, thus requiring two independent characters instead of one

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composite character to represent any particular number. This arrangement of the characters may have been more or less due to the fact that the inventor had seen the English numbers and had had these explained to him. His arrangement of these may possibly have been influenced by the arrangement of the English, and the fact that the lower numbers were not arranged in a similar manner may be because when he invented them he did not thoroughly comprehend this arrangement of the English.

In the accompanying set of these characters it will be observed that in large measure the tens are formed on the units as bases. There are, however, certain exceptions to this rule. For instance, ten, twenty, and thirty are evidently formed independently without taking the numbers one, two, and three into consideration. The remainder of the tens, however, from forty to ninety inclusive, are palpably formed directly from the units four to nine inclusive by the simple addition of some extra stroke or by the alteration of the unit character.

In view of the above-mentioned phonetic nature of this whole system it appears natural that these three numbers, ten, twenty, and thirty, should be different from their corresponding units, since the sounds involved in these three are very different from the sounds involved in the same units. Attention should be called also to the fact that the character thirty strongly resembles thirteen and that to the informant's mind the upper branching portion of the character thirteen represented the portion of this numeral which we pronounce 'thir," while the crowfoot below represented "teen," and that likewise

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the very similar lower portion of the character thirty represented the same sound "thir" while the crowfoot above it represented "ty."

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It is therefore evident that, while this set of characters is strictly mnemonic in its use, it is formed on a phonetic basis. It is, as first stated, the original invention of a single individual and in no way represents a tribal characteristic, but with it at hand this individual appeared to be greatly assisted in his difficult task of learning to count in English, and so assiduously did he study his system that in the course of a short time he was able to count fluently from one to one hundred. For a considerable length of time he was unable to do this without the aid of his set of numeral characters, but ultimately, of course, he became so familiar with this that he repeated them easily from memory.